

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Serial No. 10/634,631
USPTO Confirmation No. 7208
Attorney Docket: RCARL-001-US
Filing Date: 8/5/2003
First Named Applicant: Ralph L. Carlson

To: Commissioner for Patents
P.O. Box 1450
Alexandria, VA, 22313-1450

DECLARATION OF RALPH L. CARLSON
PURSUANT TO 37 C.F.R. § 1.132

Sir:

I, Ralph L. Carlson, declare as follows:

1. All statements herein made of my own knowledge are true, and all statements made on my information and belief are believed to be true.
2. I am the inventor named in the above-referenced patent application.

I. Background

3. I am a founder of, and currently employed as Senior Partner of, Strategic Automation, Inc., of Sandwich, Massachusetts, an engineering firm specializing in the design, fabrication, and implementation of automated machinery, including custom-fabricated automated machinery.

4. I founded Strategic Automation, Inc. in 2002.

5. The majority of the business of Strategic Automation, Inc. since 2002 has been to manufacture, sell and support sales of machines, constructed in accordance with the teachings and claims of the present application for patent, to major manufacturers of golf balls.

6. I received a B.S.E.E. Degree in 1983 from Norwich University, and an M.B.A. Degree in 1997 from the University of Massachusetts.

7. Prior to founding Strategic Automation, Inc., I was employed from 1987-1996 by the Acushnet Company, owner of the Titleist Golf brand, and an operating company of Fortune Brands, Inc., as an electrical engineer designing custom machinery for golf ball manufacturing. My responsibilities included conceptual designs for machinery, machine vision systems, motion control systems and the like.

8. Between 1996 and 2002, I worked as an independent consultant, undertaking projects for another company in the Golf Industry.

9. I have been participating in and observing the golf ball industry, and particularly, machinery for manufacturing and processing golf balls, for at least twenty years, and I have detailed knowledge of that industry and of the market for machinery for manufacturing and processing golf balls.

10. Given my education and experience, I believe that I am an expert in the field of machinery for manufacturing and processing golf balls.

11. I have reviewed in detail the text and drawings of the above-identified patent application and of the related provisional patent applications U.S. Serial Nos. 60/401,603 and 60/402,157 filed Aug. 7 and Aug. 9, 2002, respectively, upon which the present patent application is based and from which it claims priority benefit, including patent claims set forth in the referenced patent applications.

12. I have also reviewed in detail Amendments filed in the present patent application, including the Amendment filed on the same day herewith, and the amended patent claims set forth therein.

13. I note that the independent claims of the present patent application, as amended in the Amendment filed on the same day herewith, are set forth in their entireties in the attached Addendum to this Declaration, and which forms a part of this Declaration.

II. Commercial Success of the Claimed Invention, Due to the Claimed Features

14. Following the filing of the noted provisional applications in 2002, my company Strategic Automation, Inc. began marketing a machine constructed in accordance with one or more of the noted patent claims. I believe this machine has achieved outstanding commercial success, and that such success has been directly attributable to the advantages derived from the subject matter of the patent claims of the noted patent application, including those presented in the accompanying Amendment.

15. In particular, Strategic Automation, Inc. has sold at least thirteen (13) machines constructed in accordance with the teachings and claims of the present patent application, including the claims as presently amended, such sales generating in excess of \$1.3 million.

16. Sales of machines constructed in accordance with the teachings and claims of the present patent application include the following:

8 machines to Callaway Golf Company;

4 machines to TaylorMade (Adidas Golf); and

1 machine to Acushnet Company (Titleist Golf, hereinafter simply "Titleist").

17. In my opinion, and to my knowledge, no other product on the market is constructed in accordance with the noted patent claims; although in 2006, on information and belief, I became aware that

at least one manufacturer may have attempted to copy the invention we consider to be covered by the present patent application.

18. Accordingly, I believe that we have the entire market share of machines with the capability of our machine.

19. In my opinion, and to my knowledge, no other product on the market offers the combination of structures and functions required by the noted patent claims, or the advantages that stem from the structures and functions recited in the noted patent claims, which are discussed, among other places, in the noted patent application and in the accompanying Amendment.

20. In my opinion, based on direct observation of the golf ball industry for many years, my knowledge of the market for machinery for manufacturing and processing golf balls, and my detailed review of the claims of the patent application, including as amended in the Amendment filed on the same day herewith, the commercial success of the machines constructed in accordance with the present application for patent corresponds directly to the claimed invention and is directly attributable to the structures and functions recited in the noted patent claims.

21. In my opinion, the commercial success of the noted machines has been achieved in a marketplace where the consumer is free to choose on the basis of objective principles and product performance, and that success is not the result of heavy promotion or advertising, a shift in advertising, consumption by purchasers tied to Strategic Automation, Inc. by long-term "requirements" contracts, or other business events extraneous to the merits of the claimed invention.

III. My Review of the References vs. the Claims

22. I have also reviewed and studied in detail the referenced cited by the United States Patent and Trademark Office (USPTO) in USPTO Actions in the above-identified patent application, including U.S. Patent No. 5,611,723 to Mitoma (hereinafter simply "Mitoma"); U.S. 6,630,998 to Welchman (hereinafter "Welchman") ; U.S. 5,859,923 to Petry ("Petry"); U.S. 4,972,494 to White ("White"); and U.S. 5,632,205 to Gordon ("Gordon").

23. In my opinion, based on my detailed review and study of the noted references and my knowledge of the relevant area of technology, the patents to Mitoma, Welchman, Petry, White and Gordon references, taken separately or in combination, do not teach, suggest, or render obvious the subject matter of the claims set forth in the accompanying Amendment; for the reasons set forth in the Amendment and in this Declaration below; and in my opinion, the commercial success achieved by our machine constructed in accordance with one or more of the claims of the present application for U.S. Patent is further evidence of the nonobviousness of the noted patent claims.

24. Based on the claims set forth in the accompanying Amendment, compared with the text and drawings of Mitoma, Welchman, Petry, White and Gordon, it is my finding that the combinations of features required by the amended claims of the present application for patent are not present in and are not suggested by the cited references.

25. With respect to Mitoma, for example, there are a number of fundamental differences between my invention, as claimed, and Mitoma's teachings. I will go into greater detail below, but to initially summarize some of the key differences:

a) Mitoma's device is sensitive to the "attitude" of the "equator" of the ball, since his system is essentially designed to deburr the equator (presumably the seam on the ball), but his device cannot orient in three dimensions to locate a point. The best his device can do is to locate a "great circle", not a point.

b) Mitoma does not and cannot use identical workstations as my invention does.

c) Mitoma does not use the claimed single degree of freedom, 90 degree transport, and many of the other differences relate to this difference.

d) Mitoma does not use parallel axes.

e) Mitoma cannot orient the ball in three dimensions using exactly three moves, as does my invention.

26. Some of these differences can be readily seen by comparing, e.g., FIG. 7 of the present patent application vs. FIG. 1 of Mitoma, and by reviewing, e.g., Mitoma's drawings of his transport arm vs. FIG. 1 of the present application for patent. There is also a brief video presentation of my invention in operation, on the Strategic Automation, Inc. website at the following link: <http://www.strategic-automation.com/Robo-Logo.wmv> -- and I can also provide a more detailed video for review by the USPTO Examiner.

27. My review of Mitoma indicates that it teaches a system where the two imaging axes are perpendicular and their stations are mechanically quite different from one another. As a result, Mitoma's means to index the ball from one station to the next requires three moves per transport over two degrees of freedom: i.e., lift, transfer, and place. This is far more complex and potentially slower and more trouble-prone (borne out by my real-world observation of the actual machines as noted below), than the claimed invention. My invention, as recited in the amended claims of the present application for patent, uses the more efficient method of indexing the ball by rotating it through one degree of freedom to simultaneously transfer the ball and present it to a second, mechanically identical station, so that the axis of rotation of the ball at the second station is perpendicular to the previous axis of rotation, while the two stations rotate on parallel axes. The teachings of Mitoma are thus fundamentally different and in fact, diametrically opposed to the mechanisms and methods required by the claims.

28. The amended claims of the present application for patent also call for coplanar axes, which is not taught in Mitoma, in that Mitoma's axes are not coplanar. Moreover, Mitoma does not teach a system where the axes are parallel or where the ball can be indexed by a single, 90 degree rotation of an indexing means. Having the axes be parallel has the added advantage that the camera(s) can be isolated behind a pane of glass that is positioned between camera(s) and the balls, thus protecting the cameras and reducing maintenance requirements.

29. The claimed indexing mechanism of my invention rotates through one degree of freedom to index the balls from one station to the next. This is significantly more efficient and mechanically trouble-free than the pick-transfer-place method taught by Mitoma. The claimed single degree of freedom indexing mechanism also requires the stations to have parallel axes, which again, is a feature not taught or suggested by Mitoma.

30. White teaches an inspection system that uses mirrors to allow one camera to image more than one surface of a part, and the camera described is an area scan "video" camera. White does not teach or suggest how to apply the line scan camera so that it can simultaneously image two spherical objects that are spinning on separate, parallel axes; nor does he address the issue of depth-of-field that is created by his mirror system. In contrast, the claimed mirror arranged maintains the same focal distance to each ball so that depth of field is not an issue. In order to properly image a spherical object with a line scan camera the line sensor must be in line with the spin axis. For this application, the two spin axes must be positioned by the mirrors so that they both line up with the axis of the line sensor element in the camera. The balls must be positioned to also maintain the maximum use of the line sensor so that adequate resolution is maintained. The claimed invention enables this, while White and the other references neither teach nor suggest this.

31. In addition to the foregoing, it is noted that while Mitoma teaches a system that uses two rotation stations for imaging the ball, followed by two positioning stations, the method of orienting a ball in three dimensions, using the three Euler angles, is neither taught nor suggested by Mitoma. Mitoma's two positioning stations can only position the ball in two dimensions, i.e., the equator can be positioned horizontally but the ball will not be oriented around the axis that is perpendicular to the equatorial plane. Therefore a target "point" on the ball cannot be positioned (as it can be in the claimed invention); only a target "great circle" can be positioned by Mitoma's structure. And again, Mitoma does not teach or suggest rotating the ball through a 90 degree angle.

32. More particularly, Mitoma teaches a system in which a ball is rotated about two perpendicular axes ST3 and ST4, and then fine-adjusted about two more perpendicular axes at station ST5. Mitoma's first two stations ST1 and ST2 are used only for rotating the ball to acquire the image, and no positioning is done at those stations. Thus, Mitoma does not teach or suggest either orienting the ball

in three dimensions or using a set of three Euler angles required to orient the ball in three dimensions. Mitoma teaches orienting the ball in two dimensions over two positioning stations ST3 and ST4, while the claimed subject matter uses three Euler angles to orient the ball in exactly three stations. The second Euler angle has 90 degrees added to it to allow it to work with stations that have parallel axes of rotation - again, a feature not present, taught or suggested by Mitoma.

33. With regard to claims 26, 27 et seq. of the present patent application, I note that my invention, as claimed, utilizes what information is available from the first imaging station to position the ball so that all the necessary information will be attained at the second imaging station to successfully orient the ball in exactly three moves. The first imaging station ensures that the desired indicia will be found at the second station. In Mitoma, in contrast, there is no locating done at the imaging stations. If the ball's equator is not found at the first imaging station it is assumed that it will be found at the second imaging station. There is no teaching or suggestion in Mitoma of using information from a first imaging station to position the ball so that all the necessary information will be attained at the second imaging station to enable successful orientation of the ball, in three dimensions, in exactly three moves, as required by the claims.

34. Similarly, Mitoma teaches a system where the two imaging axes are perpendicular and (their stations) are mechanically quite different from one another. As a result, Mitoma's means to index the ball from one station to the next requires three moves per transport over two degrees of freedom: i.e., lift, transfer, and place. This is far more complex and potentially slower and more trouble-prone (borne out in real-world observation of the actual machines as noted herein upon my direct observation and knowledge), than the claimed invention. As required by the claims, my invention uses the more efficient method of indexing the ball by rotating it through one degree of freedom to simultaneously transfer the ball and present it to a second, mechanically identical station, so that the axis of rotation of the ball at the second station is perpendicular to the previous axis of rotation, while the two stations rotate on parallel axes. The teachings of Mitoma are thus fundamentally different and in fact, diametrically opposed to the mechanisms and methods required by the claims.

35. With regard to Gordon, the system described therein is based on using an iterative process to orient the ball. The Gordon machine repeatedly images the ball and moves it based on what it "sees" until the ball is in the correct or nearly correct orientation. Based on my real-world knowledge and observation of the various actual machines built in accordance with the Gordon design, the Mitoma design, and my own invention, the Gordon system results in variable times to orient the ball, instead of a uniform and predictable orientation time, resulting in downstream challenges for the machine. My invention, in contrast, uses exactly three moves, with a predictable time interval, to orient the ball in three dimensions.

IV. My Observation of Mitoma and Gordon Machines

36. In addition to the foregoing, I have personal knowledge and observations relating to machines constructed in accordance with the Mitoma and Gordon disclosures.

37. On information and belief, Titleist purchased a burr-removing machine described in the Mitoma reference, in or about 1995, but later substantially ceased to use the Mitoma device.

38. On information and belief, Titleist continued to have a need for a machine to orient finished golf balls so that a custom logo could be printed on them in the correct location relative to the previously-placed manufacturer's printing. On information and belief, Titleist hired Gordon (i.e., an inventor named in the Gordon reference noted above) to design the machine later described in the Gordon patent. The Gordon machine orients the ball at one station so that the machine can keep trying until the ball is successfully oriented. This allowed a higher orientation success rate, but caused the time required to orient the ball to vary significantly from one ball to the next, a significant problem for downstream processing.

39. Moreover, the average cycle rate with the Gordon machine was still less than half of what is achieved by machines constructed in accordance with my invention. Thus, until the advent of my invention, the industry still had a long-felt need to orient golf balls in all three dimensions at a high operating rate and over a highly repeatable time interval, which was not achieved by machines constructed in accordance with the Mitoma or Gordon references.

40. On information and belief, there is no machine on the market, other than the machines sold by my company Strategic Automation, Inc. and constructed in accordance with the teachings and claims of the present application for patent, that satisfies this long-felt need.

41. In the process of inventing the subject matter described and claimed in the present application for patent, I recognized that a sequential approach as described and claimed in the present patent application and not present in the prior art, was the best way to achieve higher operating rates, and devised the claimed method of using four identical, rotating stations and the rotating grippers that index the balls through the machine while simultaneously rotating them 90 degrees. This set of features, as recited in and required by the amended and new claims, is a key advantage of the claimed structures and methods. I also incorporated a mirror design as a means to reduce the cost of building the machines.

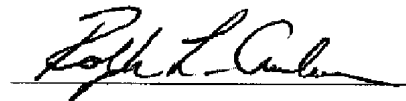
42. As a result of these differences and substantial improvements and technical advantages over the prior art, my company Strategic Automation has to date sold at least thirteen (13) machines constructed in accordance with the claimed subject matter to customers including Titleist and other major golf ball manufacturers, with total sales thereof in excess of \$1.3 million dollars, and given numerous, continuing inquiries from companies throughout the golf industry, I expect such sales to continue into the future.

43. In my opinion, there exist numerous applications for this technology in golf ball manufacturing.

44. In addition, it is my observation that there appear to be no other machines currently on the market that use machine vision to orient the ball.

I DECLARE under penalty of perjury under the laws of the United States of America that the foregoing is true and correct. I understand that willful false statements and the like are punishable by fine or imprisonment or both as set forth in 18 U.S.C. §1001, and may jeopardize the validity of the application or any patent issuing thereon.

Executed on: May 11, 2007

A handwritten signature in cursive script, appearing to read "Ralph L. Carlson", written over a horizontal line.

Ralph L. Carlson

ADDENDUM TO DECLARATION OF RALPH L. CARLSON;
INDEPENDENT CLAIMS OF U.S. PATENT APP. 10/634,631
AS AMENDED IN AMENDMENT FILED HEREWITH

1. A system for automatically orienting a spherical object using a reference indicium on the spherical object, comprising:

(A) means for automatically locating and defining a position and two-dimensional orientation of the reference indicium; and

(B) means for automatically orienting the spherical object by sequentially rotating the spherical object from the defined position and two-dimensional orientation determined by the automatic locating means through determined angles so that the reference indicium of the spherical object has a predetermined final position and two-dimensional orientation wherein a target point on the spherical object, which has a predetermined spatial relationship to the reference indicium, is positioned for further processing,

wherein the automatic locating and defining means comprises:

- (1) first and second locating work stations, each of the first and second locating work stations having a axis of rotation and being operative to rotate the spherical object around the axis of rotation;
- (2) transposing means for conveying the spherical object between the first and second locating work stations in such manner that the spherical object is rotated through a single-degree of freedom by 90 degrees between the first and second locating work stations and between the second locating work station and the orienting means, respectively;
- (3) an imaging system operative to generate an image of the spherical object at each of the first and second locating work stations as the spherical object is rotated about the axis of rotation of the first and second locating work stations through at least one revolution, respectively; and
- (4) calculating means for processing the image of the spherical object generated at the first and second locating work stations, respectively, to locate and identify the defined position and two-dimensional orientation of the reference indicium and to determine angles for rotation for the spherical object by the orienting means;

wherein the calculating means is operative to process the image of the spherical object generated at the first locating work station to identify a coarse position and two dimension orientation of the reference indicium at the first locating work station and to determine an angle of rotation for the spherical object at the first locating station;

the first locating work station means is operative to rotate the spherical object about the determined angle to move the spherical object to a second position at the first locating work station; and

the transposing means is then operative to convey the spherical object to the second locating work station wherein the spherical object is rotated through the single-degree of freedom by 90 degrees such that the reference indicium is at the defined position and two dimensional orientation on the equator of the spherical object at the second locating work station;

wherein the automatic orienting means comprises:

- (1) first, second, and third orienting work stations, each having an axis of rotation and being operative to sequentially rotate the spherical object through one of the determined angles so that the reference indicium is transposed from the defined position and two-dimensional orientation at the first orienting work station to the predetermined final position and two-dimensional orientation at the third orientating work station wherein the target point on the spherical object is positioned for further processing; and
- (2) transposing means for conveying the spherical object between the first and second and second and third orienting work stations in such manner that the spherical object is rotated through the single-degree of freedom by 90 degrees between the first and second orienting work stations and between the second and third orienting work stations, respectively;

wherein the transposing means comprises:

- (1) a first transposing mechanism pivotally mounted intermediate the first and second orienting work stations and operative to convey the spherical object from the first orienting work station to the second orienting work station in such manner that the spherical object is rotated through the single-degree of freedom by 90 degrees; and
- (2) a second transposing mechanism pivotally mounted intermediate the second and third orienting work stations and operative to convey the spherical object from the second orienting work station to the third orienting work station in such manner that the spherical object is rotated through the single-degree of freedom by 90 degrees; and

wherein the 90 degrees single-degree of freedom rotation provided by the transposing means between the first and second and the second and third orienting work stations are coplanar with the axes of rotation of the first, second, and third orienting work stations;

the second locating work station is equal to and functions as the first orienting work station; and

the determined angles of rotation implemented by the first, second, and third orienting work stations, respectively, comprise Euler angles of rotation ϕ , θ plus an additional 90 degrees, and ψ , respectively.

10. A system for automatically orienting a spherical object using a reference indicium on the spherical object, comprising:

first and second locating work stations each having an axis of rotation and operative to rotate the spherical object about the axis of rotation;

first, second, and third orienting work stations each having an axis of rotation and operative to rotate the spherical object about the axis of rotation through a determined angle of rotation so that the reference indicium at the third orienting work station has a predetermined final position and two-dimensional orientation wherein a target point on the spherical object, which has a predetermined spatial relationship to the reference indicium, is positioned for further processing;

transposing means for conveying the spherical object between the locating work stations and between the orienting work stations in such manner that the spherical object is rotated through a single-degree of freedom by 90 degrees each time the spherical object is conveyed between adjacent work stations, respectively;

an imaging system operative to generate an image of the spherical object at each of the first and second locating work stations as the spherical object is rotated about the axis of rotation of the first and second locating work stations, respectively; and

calculating means for processing the images of the spherical object generated at the first and second locating work stations to locate and identify a defined position and two-dimensional orientation of the reference indicium at the second locating work station and to determine the angles of rotation for the spherical object at the first, second, and third orienting work stations wherein the reference indicium is rotated from the defined position and two-dimensional orientation at the first orienting work station to the predetermined final position and two-dimensional orientation at the third orienting work station so that the target point is positioned for further processing; wherein:

the second locating work station is equal to and functions as the first orienting work station;

the first orienting work station is operative to rotate the spherical object through one of the determined angles of rotation such that the reference indicium of the spherical object is moved from the defined position and two-dimensional orientation at the first orienting work station to a first reference position and two-dimensional orientation at the first orienting work station; and wherein

the transposing means is then operative to convey the spherical object from the first orienting work station to the second orienting work station so that the reference indicium is moved to a second reference position at the second orienting work station; and wherein

the second orienting work station is operative to rotate the spherical object through another of the determined angles of rotation such that the reference indicium of the spherical object is moved from the

second reference position and two-dimensional orientation at the second orienting work station to a third reference position and two-dimensional orientation at the second orienting work station; and wherein

the transposing means is then operative to convey the spherical object from the second orienting work station to the third orienting work station so that the reference indicium is moved to a fourth reference position at the third orienting work station; and wherein

the third orienting work station is operative to rotate the spherical object through yet another of the determined angles of rotation such that the reference indicium of the spherical object is moved from the fourth reference position and two-dimensional orientation at the third orienting work station to the predetermined final reference position and two-dimensional orientation at the third orienting work station such that the target point on the spherical object is positioned for further processing; and.

wherein the one, another, and yet another determined angle of rotation implemented by the first, second, and third orienting work stations, respectively, comprise Euler angles of rotation ϕ , θ plus an additional 90 degrees, and ψ , respectively.

25. A method of automatically orienting a spherical object using a reference indicium on the spherical object so that a target point, which has a predetermined spatial relationship with the reference indicium, is positioned for further processing, comprising:

locating and defining a position and two-dimensional orientation of the reference indicium on the spherical object;

calculating, based on the defined position and two-dimensional orientation of the reference indicium, angles of rotation for the spherical object to move the reference indicium from the defined position and two-dimensional orientation to the predetermined final position and two-dimensional orientation;

rotating the spherical object at a first orienting work station through one of the calculated angles of rotation to move the reference indicium from the predefined position and two-dimensional orientation to a first reference position and orientation at the first orienting work station;

conveying the spherical object from the first orienting work station to a second orienting work station in a manner such that the spherical object is rotated through a single-degree of freedom by 90 degrees wherein the reference indicium is at a second reference position and two-dimensional orientation at the second orienting work station;

rotating the spherical object at the second orienting work station through another of the calculated angles of rotation to move the reference indicium from the second reference position and two-dimensional orientation to a third reference position and two-dimensional orientation at the second orienting work station;

conveying the spherical object from the second orienting work station to a third orienting work station in a manner such that the spherical object is rotated through a single degree of freedom by 90 degrees wherein the reference indicium is at a fourth reference position and two-dimensional orientation at the third orienting work station; and

rotating the spherical object at the third orienting work station through yet another of the calculated angles of rotation to move the reference indicium from the fourth reference position and two-dimensional orientation to the predetermined final position and two-dimensional orientation at the third orienting work station wherein the target point is positioned for further processing;

wherein the one, another, and yet another calculated angles of rotation, respectively, comprise Euler angles of rotation ϕ , θ plus an additional 90 degrees, and ψ , respectively

27. A system for imaging the surface of a spherical object, comprising:

a first work station having an axis of rotation and operative to rotate the spherical object about the axis of rotation, and wherein a plane of the spherical object perpendicular to the axis of rotation is defined as the rotational plane of the spherical object at the first work station;

a second work station having an axis of rotation and operative to rotate the spherical object about the axis of rotation, and wherein a plane of the spherical object perpendicular to the axis of rotation is defined as the rotational plane of the spherical object at the second work station;

transposing means for conveying the spherical object from the first work station to the second work station in such manner that the spherical object is rotated through a single degree of freedom by 90 degrees wherein the rotational plane of the spherical object at the first work station is rotated through an angle of 90 degrees such that the rotational plane defined by the spherical object at the first work station is perpendicular to the rotational plane of the spherical object at the second work station; and

an imaging system positioned and operative to generate an image of the surface of the spherical object at each of the first and second work stations; and wherein

the imaging system is operative to generate a first image of the surface of the spherical object as the spherical object is rotated through at least one complete revolution about the axis of rotation of the first work station; and wherein

the imaging system is operative to generate a second image of the surface of the spherical object as the spherical object is rotated through at least one complete revolution about the axis of rotation of the second work station; and

the first and second work stations are substantially identical in structure.